Molecular Rayleigh scattering to measure fluctuations in density in low speed heated wind tunnel flows

J. Panda*, NASA Ames Research Center, Moffett Field, CA
S. D. Schery, Aerospace Computing Inc., Mountain View, CA

Abstract:
We used the support from the ARMD seedling fund to setup a molecular Rayleigh scattering based technique with the ultimate goal of simultaneous measurement of fluctuations in density, velocity, and temperature for wind tunnel applications. It was the first such setup at NASA ARC. All optical and electronic components were purchased, and optical trains were designed and implemented for two different setups. The first one was a proof-of-concept arrangement around a small heated jet, where intensity of the Rayleigh scattered light was measured using a two-PMT arrangement, and fluctuations in the air density were measured with high signal to noise ratio. Work is in progress to further develop this facility for spectroscopic analysis of the scattered light to measure velocity and temperature. The second setup was in a low-speed wind tunnel of the Fluid Mechanics Laboratory where various challenges associated with particle cleaning, vibration isolation and stray light reduction had to be overcome to obtain a cleaner signature of the Rayleigh scattered light. Additionally a special calibration process had to be applied to relate air density to the photo-electron arrival rate from probe locations close to the plate surface. The test object in the wind tunnel setup is the thermal boundary layer created over a heated flat plate. Work is in progress to survey density fluctuations spectra during transition to turbulence. It is believed that the present work is the first measurement of density fluctuations spectra in a boundary layer flow.